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PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Improvements in or relating to Coating Methods

We, REED PAPER GROUP LIMITED, a British Company of 82 Piccadilly, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with improvements in or relating to the application of coatings to surfaces to form surface layers thereon and is particularly concerned with the application of coatings to surfaces which are difficult to coat, for example, because of their rough texture or absorbent nature. The invention, is, in particular, concerned with the coating of paper and board where these problems are particularly acute.

By applying coatings to paper and board, surface properties of the latter can be transformed while still retaining many of their desirable qualities e.g. low density and flexibility. Many processes have been proposed for coating paper, in particular, in order to obtain distinctive properties, for example improved opacity, improved receptivity to printing inks and reduced permeability to water and water vapour. Coatings compositions useful in the production of such coatings normally contain water or a volatile organic liquid as a carrier for the coating component and although useful coatings can be obtained from such compositions, the application of the compositions to paper and board leaves much to be desired. When using aqueous emulsions, for example, the water may penetrate the substrate thus requiring additional drying facilities and moreover the coating component may be present in substantial quantities in the interstices of the paper or board rather than on the surface where it is required.

Board for use in manufacturing cartons is frequently overlaid with paper on one side leaving the remaining side with a rough texture and absorbent character. For many applications it is necessary to coat the other side with a barrier coating to prevent migration of the contents of the carton. This can be achieved by applying a single layer of a molten material e.g. wax or polyethylene. The application of layers to form effective barrier coatings from solvent and emulsion systems is not practical firstly because of the absorbency of the board and secondly because of the rough texture of the board which results in uneven coverage.

In an attempt to overcome this problem a foam of the coating composition was formed and applied to the board thus forming a thick layer of foam on the board. The applied form was however very slow in drying and, when dry, yielded a coating lacking in barrier properties. It was found however that foamed coating compositions could be applied to surfaces to yield useful coatings (consistent with the properties of coating components thereof) if at least a part, and preferably substantially all, of the applied foam was mechanically broken down. In this way useful barrier coatings have been produced on rough textured carton board.

An important advantage of this process is that the composition can be used to form a coating on the surface without, in the case of absorbent material, significant wetting of the material by the liquid medium for the coating composition. Where the surface possesses a rough texture, as in the case of carton board, a coating of a relatively thin nature can be produced over the whole of the surface area, that is to say in the "valleys" as well as on the "slopes" and the "crests".

However, the process is not limited to this rather specialised application and is very useful in the application of many coating compositions to paper, the method having advantages over conventional coating methods in the paper and board industry especially where the coating is applied to the paper or board as

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an integral part of the manufacturing process. The method can thus be employed in general whenever one wishes to apply a liquid coating composition to paper or board e.g. to improve the printing qualities thereof, especially where the liquid coating composition is water-based.

According to the invention, therefore, there is provided a method of applying a coating on a surface of a web of paper or board which comprises forming a foam of a liquid coating composition comprising at least one coating component with a gas or vapour, applying said foam to a surface and mechanically disintegrating substantially all of the foam to form a continuous surface coating over the coating area.

The coating composition used in the process according to the invention may contain as coating component any one or more of the following materials:—

A. Plastomeric or elastomeric vinyl polymers of copolymers, for example, polyethylene, polyvinyl chloride, polyvinylidene chloride, chlorinated polyvinyl chloride, polymethyl methacrylate, polyacrylic acid, polyvinyl alcohol, polyvinyl acetate, butadiene-styrene, copolymers, acrylonitrile - butadiene - styrene terpolymers, butadiene-acrylonitrile copolymers, natural rubber, synthetic polyisoprene, polybutadiene and butyl rubber.

B. Condensation polymers whether or not of a thermoplastic nature, for example, aminoplasts, e.g. urea-formaldehyde and melamine formaldehyde, phenoplasts e.g. phenol-formaldehyde, polyesters and polyamides.

C. Polysaccharides and derivatives thereof including starch, cellulose, cellulose acetates, carboxy-methylcellulose, ethyl cellulose, plant gums and mucilages e.g. mannan gums such as locust bean gum and guar gum.

D. Animal and vegetable proteins, e.g. casein and gelatin.

E. Inorganic polymers, e.g. silicates of alkali metals and alkaline earth metals, and clays.

F. Organosilicon polymers.

G. Waxes, synthetic and natural e.g. paraffin wax, microcrystalline wax, halowaxes, beeswax and carnaubawax.

H. Rosin and rosin derivatives e.g. hydrogenated rosin.

I. Siccative and semi-siccative oils e.g. linseed oil, dehydrated castor oil, tung oil, oiticia oil and pentaerythritol tetralinolcate.

J. Potentially reactive compositions e.g. epoxy resins in combination with polyamides, polyamines or polyesters.

Where the coating component is normally liquid this may be used without the addition of any volatile liquid but with the addition of other desired materials e.g. surface active agents and pigments.

However, the method according to the invention is especially applicable to water-based coating compositions for example, in the form of a polymer latex. It can also be used for the application of coatings from compositions wherein the liquid medium is an organic solvent in which the binder is either dissolved, dispersed or emulsified.

In addition to the binder and liquid medium, the coating composition may also contain other ingredients, for example surface-active agents, pigments, fillers, dyestuffs and vapour phase corrosion inhibitors according to the intended usage. It is particularly advantageous to use water-based compositions containing a surface-active agent since the latter is of value in the formation of the foam. The surface active agent may be anionic, cationic, ionic or amphoteric according to the nature of the other ingredients in the composition.

In order to improve the viscosity of the coating composition this may contain one or more thickening agents including substances which otherwise function as binders e.g. polyvinyl alcohol and gums.

The relative proportions of the various components of the coating composition will depend on the nature and function of the desired coating.

In order to convert the coating composition to a foam structure it is subjected to the action of gas or vapour at normal or superatmospheric pressure. For most purposes air is a suitable gas. However other gases as well as vapours may be used. For example, if the coating composition is oxygen-sensitive one may use an inert gas such as nitrogen or carbon dioxide. Other gases which may be used include fluoro- and chlorofluoro-alkanes and -cycloalkanes. Alternatively, the gas may be formed *in situ* by reaction of two or more substances e.g. acid/alkali systems.

The coating composition is preferably foamed to at least twice and advantageously at least four times its original volume. A range of 2—10 times the original volume is a fairly practical range. The coating composition may be foamed by any convenient means e.g. one of the mixers employed in the expanded rubber industry to produce rubber foams. Preferably the foam is substantially immobile.

In the case of an endless web such as paper or board the foam is preferably applied to the surface and disintegrated by a knife or edge extending across the width of the web. An example of such means is a trailing edge (see Tappi, *43*, No. 2, page 200A). Alternatively one may use an air knife, rolls, Meyer rod or reciprocating brush coater. Whatever means is used to apply the foam it is imperative that a substantial proportion of the structure of the

foam be mechanically broken down. Thus, when using a trailing edge or blade this should be set so that it is impossible for the foam to pass under the edge or blade and emerge without disintegrating in part. For practical purposes the edge or blade should be set so that its coating edge is in physical contact with the surface of the web to be coated where one wishes to disintegrate virtually all of the foam. A similar practical rule also applies to rolls and Meyer rods.

Although for many applications it is convenient to apply the foam and effect its destruction by a single means e.g. a trailing edge, this is not essential. Thus the foam may be applied to the surface by means of a doctor blade or trailing edge set at an interval from the surface to be coated to form a regular layer of foam on the surface. The layer of foam may then be allowed in part to collapse physically prior to the mechanical disintegration of the residue, e.g. by a trailing edge.

It will be appreciated that the method according to the invention can be applied to individual sheets e.g. of plaster board and hard board.

The foam is advantageously supplied to the coating means via a manifold, the volume of foam emerging therefrom being controlled according to the uptake of composition by the surface being coated.

It may be found necessary, particularly when coating an endless web, to coat the surface at least twice in order to obtain a coating of the desired character. In this case two or more coating means may be employed in series with an adequate interval between each to obtain satisfactory drying of the coating from the previous coating operation.

The method according to the invention can be advantageously employed on a paper- or board-making machine to enable a liquid coating composition to be applied at some point during or after drying. By applying the coating composition to the paper as a foam, rather than as a liquid, more careful control can be exercised. Thus, most coating compositions must be kept mobile during use to prevent settling and when a breakage in the paper occurs, it is difficult to control the liquid due to its mobility. On the other hand, if a breakage occurs when using a foam, the application of foam can be terminated by a valve and the machine re-started without having to worry unduly about the mobility of the foam. By coating the paper or board on the machine the need for a separate coating operation is obviated. This is important in considering the efficiency of the method.

The method of the invention is advantageous in the coating of paper to obtain relatively thin, special effect coatings e.g. the application of light weight clay coatings to base paper of high mechanical pulp content to improve its brightness; and the application of light weight opacifying coating (for example, containing titanium dioxide). The method also finds application in the manufacture of coated papers for lithographic printing and in the coating of newsprint with pigmented coating compositions, e.g. pigmented starch pastes, to yield surfaces having improved printing surfaces.

The process according to the invention is also of particular value in the coating of carton board with polyvinylidene chloride aqueous emulsions to obtain water vapour resistant coatings.

In order that the invention may be well understood the following examples are given by way of illustration only. Parts are by weight unless otherwise stated.

Example 1.

Coating of Cartonboard.

This example shows that foaming of thermoplastic emulsion allows its economic application to the rough, absorbent reverse side of a white lined chip cartonboard.

An emulsion of polyvinylidene chloride aqueous latex, which was previonsly difficult to use due to its marked foaming tendency, was used. A solution of polyvinyl alcohol was added to the latex in order to stabilise the resulting foam. A stable foam of four times the original volume of the mixture was prepared from this composition by whipping with air. The foam was applied to the reverse side of white lined chip board using a number 4 Meyer rod. Coating was extremely easy and was unattended by cockling and other difficulties normally encountered when aqueous coatings are applied to absorbent paper surfaces. Multiple coatings were also prepared.

Thus a series of coated boards were produced having from one to five coats. These were rested for coating weight and for resistance to oleic acid at 80°C. and to moisture vapour transmission, with the following results:—

No. of Coats	Coating Weight (grams/sq. metre)	Resistance to	
		Oleic Acid at 80°	Moisture Vapour* (Tropical Humidity)
1	3.5	1 hr. 30 min.	1939
2	6	3 hrs. 10 min.	423
3	8	very	47
4	9	high	28
5	10	resistance	12

* expressed as grams per square metre for 24 hours at 30° C. and 90% relative humidity.

The composition used in this example has the following formulation:—

Alcotex 99/30[1]	10 parts
Polidene 901[2]	125 parts

1. Aqueous polyvinyl alcohol, 10% solids, mol. wt. 70—80,000; "Alcotex" is a registered Trade Mark.
2. Polyvinylidene chloride emulsion, 50% solids, containing a mixed system of anionic and non-anionic surface active agents; "Polidene" is a registered Trade Mark.

EXAMPLE 2.

Pigmented Coating of Newsprint.

In this example it was intended to show that foamed versions of pigmented paper coating compositions could be applied with great ease to a flimsy water-sensitive web of newsprint.

A coating composition prepared from china clay, casein and a latex of styrene-butadiene copolymer was foamed with air to four times its original volume without extra additions. This foam was applied to newsprint by a trailing blade attachment fitted to a laboratory coating machine. A closed loop of paper was used so that multiple coatings could be applied to the newsprint in rapid succession by repeated passage through the trailing blade device.

Examples were prepared having one to five coatings applied as above. These were tested for coating weight and were examined for print quality, with the following results:—

No. of Coats	Coating Weight lbs/2000 sq. ft.	Print Quality
0	0	Very poor
1	2	Fair
2	4	Good
3	6	Very good
4	8	Very good
5	10	Very good

EXAMPLE 3.

This example shows that a foam of an otherwise conventional starch coating composition may be satisfactorily applied by the method according to the invention using a trailing blade attachment attached to a laboratory coating machine.

The following composition:—

Clay	40 parts
Starch	8 parts
Water	52 parts
Foaming Agent*	0.03 parts

was foamed to 5 times its original volume and applied to a variety of papers as described above. Uniform coatings of good hiding power were obtained.

EXAMPLE 4.

This example shows the use of the process according to the invention to apply coatings of high covering power.

A pigmented composition containing:

Titanium Dioxide	35 parts
Water	35 parts
Acrylic Resin Emulsion	25 parts
Colour	5 parts
Foaming Agent	0.03 parts

was foamed to 5 times its original volume and applied to unbleached kraft and other papers on a laboratory coating machine as described in Example 3. The experimental products showed uniform coverage and the hiding power of the coatings applied to the kraft in particular was sufficient to mask the strong background colour of this paper.

EXAMPLE 5.

This example, like Example 3, shows the application of a clay coating to paper but employing a different binder, viz polyvinyl alcohol. This binder is particularly useful for the production of foams according to the invention.

Pigmented compositions containing prepared according to:

China Clay	15—35 parts
Water	85—65 parts
Medium Viscosity Polyvinyl Alcohol	1.2 —2.8 parts
Foaming Agent	0.03—0.15 parts

were foamed to 6—10 times their original volumes and were applied to various papers in the drying section of a paper making machine, by means of a trailing blade at which point the foams were substantially destroyed and a thin uniform coating produced. Drying was completed in the remainder of the drying section.

EXAMPLE 6.

This example illustrates the use of the process of the invention for quite a different purpose i.e. the production of release coatings on paper. The composition used is a reactive one.

A mixture containing prepared acording to:

Silicone resin[1] 40% aqueous emulsion	5.70 parts
Catalyst[2]	1.14 parts
Foaming agent	2.28 parts
Carboxymethyl cellulose solution 1%	68.28 parts
Water	22.60 parts

1. MS 2218 supplied by Midland Silicones Ltd.
2. MS 2230 supplied by Midland Silicones Ltd.

* The foaming agent in this and the subsequent examples was a 10% aqueous solution of 75% aqueous sodium lauryl sulphate.

was foamed to 5—10 times its original volume and applied to kraft papers by the method of Example 2. Adequate "release" properties were obtained at coating weights below those applied by more conventional methods. By "release" properties is meant the reduction in friction between the surface and substances coming into contact therewith.

EXAMPLE 7.

A mixture containing:

High Viscosity grade of Carboxymethyl Cellulose	2 parts
Water	98 parts
Foaming Agent	0.03 parts

was foamed to 7 times its original volume and was applied to paper in the drying section of a paper making machine as described in Example 5. In this way uniform coatings of carboxymethyl cellulose were obtained.

A variety of water-soluble dyestuffs normally added to the beaters of paper machines were added to mixtures of carboxymethyl cellulose of this type. These additions confirmed the uniformity of the application of carboxymethyl

cellulose and at the same time demonstrated the utility of the process according to the invention for the surface colouring of paper by water-soluble dyestuffs.

EXAMPLE 8.

A solution containing prepared according to:

Urea formaldehyde Resin Precondensate aqueous Syrup (50% solids)	10 parts
Water	90 parts
Foaming Agent	0.03 parts

was foamed to 7 times its original volume and applied to paper in the drying section of a paper making machine, as described in Example 5. A small amount of a water-soluble dyestuff was included to show the uniformity of the treatment. The resulting paper product showed greatly increased surface cohesion.

WHAT WE CLAIM IS:—

1. A method of applying a coating on a surface of a web of paper or board which comprises forming a foam of a liquid coating composition comprising at least one coating component with a gas or vapour, applying said foam to a surface and mechanically disintegrating substantially all of the foam to form a continuous surface coating over the coating area.

2. A method as claimed in claim 1 in which the surface of the web is coated on the paper or board-making machine as an integral part of the manufacturing process.

3. A method as claimed in claim 1 or claim 2 in which said coating component is a vinyl polymer or copolymer.

4. A method as claimed in claim 3 in which the vinyl polymer or copolymer is used in the coating composition in the form of a latex.

5. A method as claimed in claim 3 in which the vinyl polymer is polyvinyl alcohol and is used in the form of an aqueous solution in the coating composition.

6. A method as claimed in claim 1 or claim 2 in which said coating component is a condensation polymer.

7. A method as claimed in claim 1 or claim 2 in which said coating component is a polysaccharide or derivative thereof.

8. A method as claimed in claim 1 or claim 2 in which said coating component is an animal or vegetable protein.

9. A method as claimed in claim 1 or claim 2 in which said coating component is an organosilicon polymer.

10. A method as claimed in claim 1 or claim 2 in which said coating component is an inorganic polymer.

11. A method as claimed in any of the preceding claims in which the coating composition contains one or more of surface active agents, pigments, fillers, dyestuffs and vapour phase corrosion inhibitors.

12. A method as claimed in any of the preceding claims in which the gas is air.

13. A method as claimed in any of the preceding claims in which the coating composition is foamed to at least twice its original volume.

14. A method as claimed in any of the preceding claims in which the coating composition is foamed to at least four times its original volume.

15. A method as claimed in claim 13 or claim 14 in which the coating composition is foamed to up to 10 times its original volume.

16. A method as claimed in any of the preceding claims in which the foam is substantially immobile.

17. A method as claimed in any of the preceding claims in which the foam is applied to the surface and disintegrated by means of a knife or edge extending across the surface.

18. A process as claimed in any of the preceding claims in which the foam is supplied to the coating means *via* a manifold.

19. A process as claimed in claim 1 substantially as herein described.

20. A process as claimed in claim 1 substantially as herein described in any of the Examples.

21. Paper or board when coated by a process as claimed in any of the preceding claims.

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